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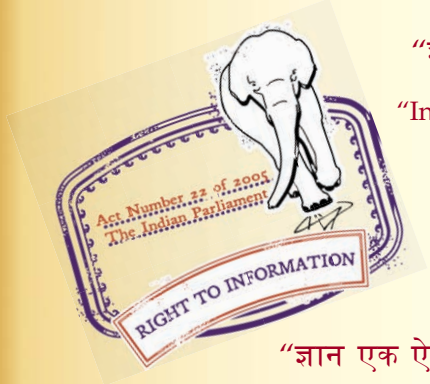
IS 9000-15-1 to 9 (1982): Basic Environmental Testing Procedures for Electronic and Electrical Items, Part 15: Sealing Test (Sections 1-9) [LITD 1: Environmental Testing Procedure]



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IS : 9000 (Part XV/Sec 1 to 9) - 1982
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Indian Standard

BASIC ENVIRONMENTAL TESTING PROCEDURES FOR ELECTRONIC AND ELECTRICAL ITEMS

PART XV SEALING TEST

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PART XV SEALING TEST

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BASIC ENVIRONMENTAL TESTING PROCEDURES FOR ELECTRONIC AND ELECTRICAL ITEMS

PART XV SEALING TEST

0. FOREWORD

0.1 This Indian Standard (Part XV) was adopted by the Indian Standards Institution on 29 January 1982, after the draft finalized by the Environmental Testing Procedures Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

0.2 The differences in environmental testing procedures for component type items and equipment type items are fast disappearing in the context of technological developments. It is, therefore, found necessary to have uniform testing procedures wherever possible. This series of standards on environmental testing procedures (IS : 9000) has been prepared with this objective. This is also in line with the principle adopted by IEC/TC 50 Environmental testing in developing unified series of standards on environmental testing procedures by International Electrotechnical Commission.

0.2.1 It is proposed to withdraw the existing Indian Standards, namely, IS : 589-1961* and IS : 2106† series dealing with environmental test for electronic components and equipment respectively, as soon as the tests mentioned therein are covered in the new series (IS : 9000).

0.3 This standard (Part XV) deals with test procedures for sealing test applicable to electronic and electrical items. The guidance details are covered in IS : 9001 (Part VIII)-1982‡.

0.4 In preparing this standard, assistance is derived from the following:

IEC Pub 68-2-17 (1978) Basic environmental testing procedures: Part 2 Tests — Test Q: Sealing. International Electrotechnical Commission (IEC).

*Basic climatic and mechanical durability tests for components for electronic and electrical equipment (*revised*).

†Environmental tests for electronic and electrical equipment.

‡Guidance for environmental testing. Part VIII Sealing test.

IEC Pub 147-5 (1977) Essential ratings and characteristics of semiconductor devices and general principles of measuring methods: Part 5 Mechanical and climatic test methods. International Electrotechnical Commission (IEC).

JSS 50101-1972 Environmental test methods for service electronic components. Directorate of Standardization, Ministry of Defence, Government of India.

JSS 55555-1977 Environmental test methods for electronic and electrical equipment. Directorate of Standardization, Ministry of Defence, Government of India.

0.5 In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960*.

*Rules for rounding off numerical values (*revised*).

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BASIC ENVIRONMENTAL TESTING PROCEDURES FOR ELECTRONIC AND ELECTRICAL ITEMS

PART XV SEALING TEST

Section 1 General

1. SCOPE

1.1 This standard (Part XV/Sec 1) deals with general information on sealing tests as applicable to electronic and electrical items.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following terms and definitions, in addition to those given in IS : 9000 (Part I)-1977* shall apply.

2.1 Leak Rate — The quantity of a dry gas at a given temperature that flows through a leak per unit of time and for a known difference of pressure across the leak.

2.2 Standard Leak Rate — The leak rate under standard conditions of temperature and pressure differential.

NOTE — For the purpose of this test, the standard conditions are 25°C and 100 kPa.

2.3 Measured Leak Rate (R) — The leak rate of a given device as measured under specified conditions and employing a specified test gas.

NOTE 1 — Measured leak rates are often determined with helium employed as the test gas under a pressure differential of 100 kPa at 25°C.

NOTE 2 — For the purpose of comparison with leak rates determined by other methods of testing, the leak rates shall be converted to equivalent standard leak rates.

2.4 Equivalent Standard Leak Rate (L) — The standard leak rate of a given device, with air as the test gas.

2.5 Time Constant (of Leakage) (θ) — The time required for equalization of partial pressure differential across a leak if the initial rate change of that pressure differential were maintained. For the purpose of this

*Basic environmental testing procedures for electronic and electrical items: Part I General.

test, the time constant is equal to the quotient of the internal volume of the item and equivalent standard leak rate.

2.6 Gross Leak — Any leak the equivalent standard leak rate (L) of which is greater than 10^{-6} Pa.m^3/s.

2.7 Fine Leak — Any leak the equivalent standard leak rate (L) of which is smaller than 10^{-6} Pa.m^3/s.

2.8 Virtual Leak — The semblance of a leak caused by slow release of absorbed, adsorbed or occluded gas.

3. CLASSIFICATION OF SEALING TESTS

3.1 The sealing tests covered by this standard are classified as follows:

a) Sealing of bushes, spindles and gaskets (Section 2);

b) Container sealing, gas leakage (Section 3);

c) Container sealing, seepage of filling liquid (Section 4);

d) Sealing-tracer gas (helium) method with mass spectrometer (Section 5);

e) Bomb pressure test (Section 6);

f) Immersion (Section 7);

g) Sealing-radioactive tracer gas (Krypton) method (Section 8); and

h) Sealing-test for equipment (Section 9).

3.2 A family tree covering different types of sealing tests is given in Fig. 1.

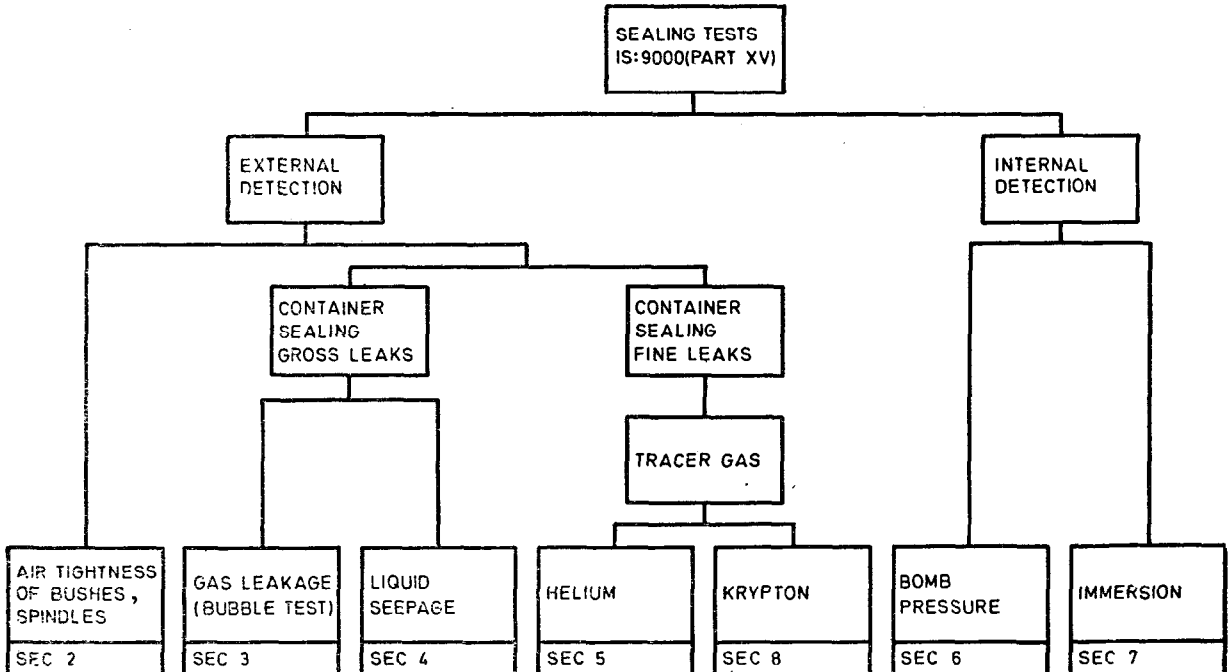

FIG. 1 FAMILY OF SEALING TESTS

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Indian Standard

BASIC ENVIRONMENTAL TESTING PROCEDURES FOR ELECTRONIC AND ELECTRICAL ITEMS

PART XV SEALING TEST

Section 2 Sealing of Bushes, Spindles and Gaskets

1. SCOPE

1.1 This standard (Part XV/Sec 2) deals with the method for determining the air-tightness of bushes, spindles and gaskets.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions and explanation of terms as given in IS : 9000 (Part I)-1977* and Sec 1 of this standard shall apply.

3. OBJECT

3.1 The object of this test is to determine the effectiveness of seals of bushes, spindles and similar features.

4. TYPES OF SEALS

4.1 The types of seals are classified as follows:

a) Static seals, for example, mounting bushes having seals under permanent compression, such as, rubber gaskets; seals of connectors and adaptor seals; and

b) Operational seals, for example, spindle and switch-level seals.

5. GENERAL DESCRIPTION OF TEST

5.1 The item is mounted on the lid of a pressurized test chamber which is submerged in a liquid. If the item leaks, the air escaping is collected. The amount of air collected per unit time is a measure of air leakage.

6. TEST APPARATUS

6.1 The sealed test apparatus shall be capable of withstanding and maintaining pressure differentials as specified.

*Basic environmental testing procedures for electronic and electrical items: Part I General.

6.2 The apparatus shall be fitted with an air inlet nozzle, air line and a suitable valve.

6.3 The item shall be mounted on the lid of the apparatus.

6.4 The item shall be connected to a suitable operating mechanism for mechanical operation.

NOTE — Suitable apparatus for this test for pressures not greater than 110 kPa is described in Appendix A.

7. INITIAL MEASUREMENTS

7.1 The items shall be visually inspected and electrically and mechanically checked as required by the relevant specification.

8. CONDITIONING

8.1 Unless otherwise specified, a pressure differential shall be applied across each seal or simultaneously across a group of seals forming an assembly as specified below:

a) For static seals: 100 to 110 kPa in the direction specified in the relevant specification; and

b) For operational seals: 100 to 110 kPa in each direction.

8.1.1 Where a higher pressure is required, it shall be 340 to 360 kPa.

8.2 Operational seals shall be tested both in a static condition and while being mechanically operated as required by the relevant specification.

9. FINAL MEASUREMENTS

9.1 The rate of leakage shall be measured. The limit shall be prescribed in the relevant specification.

10. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

10.1 When this test is included in the relevant specification, the following information shall be given as far as applicable:

	Clause Ref
a) Initial measurements	**7**
b) Electrical and mechanical checks to be made prior to the test	**7.1**
c) Requirements for pressure	**8.1**
d) Direction of application of pressure differential for static seals,	**8.1**(a)
e) Mechanical operation during conditioning	**8.2**
f) Requirements for leakage rate	**9.1**
g) Any deviation from the test procedure	—

APPENDIX A

(*Clause* 6.4)

TEST APPARATUS FOR SEALING OF BUSHES, SPINDLES AND GASKETS

(APPLICABLE FOR PRESSURES NOT GREATER THAN 110 kPa)

A-1. PRINCIPLE OF OPERATION

A-1.1 The item is mounted on the lid of a small sealed test chamber which, in turn, is fitted with an air inlet nozzle, air line and valve (*see* Fig. 1).

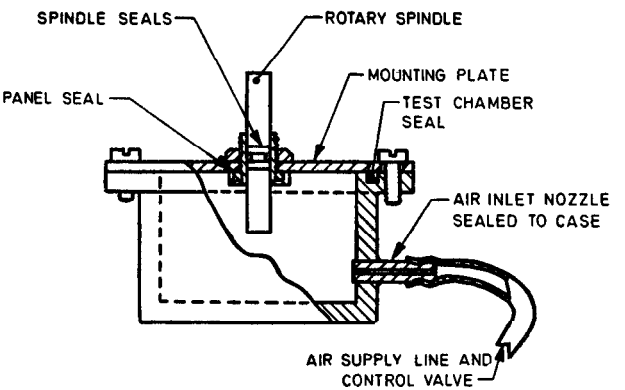

FIG. 1 CHAMBER FOR SEALING TEST

A-1.2 Air is then pumped into the sealed component, or test chamber, until the desired air pressure for the test is reached. The whole is then submerged in a liquid at the specified test temperature. If the test component leaks, a stream of air bubbles will be observed escaping from it.

A-1.3 The apparatus is shown diagrammatically in Fig. 2. A transparent funnel is fitted with a long tube, the end of which can be sealed by a tap. The funnel is submerged in the liquid with the tap open. Liquid is then drawn up the tube until it is filled and the tap is then closed. The tube is held in a vertical position and the mouth of the funnel moved over the test component so that the stream of air bubbles can be collected. The transparent funnel or collector enables this to be done quickly. The air bubbles rise and travel up the neck of the funnel into the tube and collect

at the top causing a depression of the liquid column. The rate of depression of the liquid meniscus is a measure of the leakage rate and can be measured by means of a calibrated scale and a timing mechanism, the air leakage rate being expressed in the form of cubic capacity per unit time

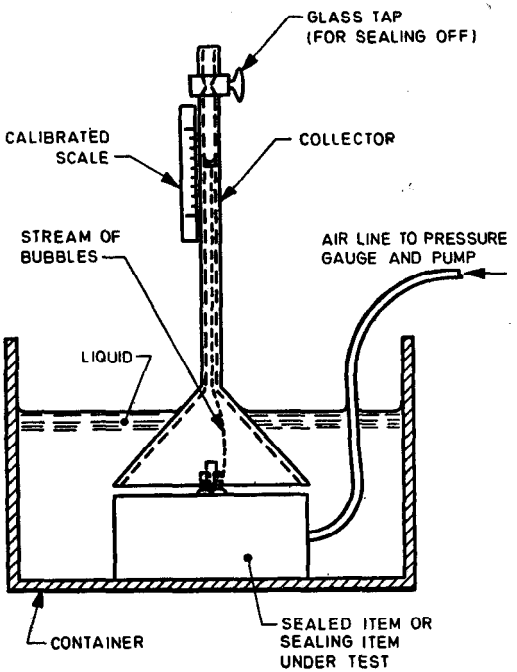

FIG. 2 APPARATUS FOR SEALING TEST

A-1.4 The apparatus will operate over a wide temperature range providing suitable liquids are chosen which at low temperature have a low viscosity and at high temperature remain stable almost to boiling point. Stability here means the non-escape of gases (or other movement which would mask the escape of air bubbles) and a low volatility. Alcohol is a suitable liquid for the low-temperature tests or paraffin for the high-temperature tests.

A-2. OPERATION

A-2.1 The liquid in the container is first brought to the required temperature of the test and then constantly stirred in order to maintain a uniform temperature in the liquid during the period of the test.

A-2.2 The air in the test chamber is compressed to the requisite pressure which the test condition demands. The test chamber is then carefully immersed in the liquid and the position of any leak is immediately disclosed by a stream of air bubbles rising to the surface. A suitable time interval shall be allowed for the component to attain temperature stability.

A-2.3 The funnel of the collector is placed in the liquid with its mouth submerged and some of the liquid is drawn up the tube by suction.

A-2.4 The funnel end is then moved over the stream(s) of air bubbles so that they are all collected and rise up the neck into the tube. Care shall be taken to keep the collector tube vertical and also to maintain the depth of immersion of the mouth of the funnel at the same constant figure as is used for calibration purposes.

A-2.5 The tube of the collector is calibrated in cubic centimetres leakage rate can be calculated by measuring the depression of the liquid meniscus during a known interval of time. The result can be readily expressed in cubic centimetres per hour.

A-3. CALIBRATION AND ACCURACY

A-3.1 The collector can be calibrated by drawing up a quantity of liquid into the tube and sealing off. A hypodermic syringe is then used as an air pump and known volumes of air are injected, in steps, through the liquid into the mouth of the funnel. At each step, the level of the displaced liquid is marked on the tube, or its scale, until a suitable complete scale is obtained. During calibration, the mouth of the funnel shall be kept at a constant depth of immersion otherwise a small calibration error may occur, due to a change in pressure in the column, caused by any variation in the head of liquid.

A-3.1 The air-leakage rate can be measured at any temperature or pressure provided the whole of the tube and scale is maintained at the specified temperature. Normally, leakage rates are expressed at room temperature and pressure; and this can readily be done because the collected air at the top of the tube quickly attains room temperature.

A-3.3 The overall accuracy of measurement of leakage rates depends on the individual accuracy of measurement of a number of factors, the chief being:

a) Air pressure,

b) Stability of the air pressure,

c) Volume of air in the collector tube,

d) Time taken to attain a specified volume,

e) Head or pressure of the liquid in the collector tube, and

f) Temperature of the liquid.

A-3.4 The errors introduced by the measurement of pressure (a) are directly proportional to the leakage rate and this percentage error, together with the errors introduced by the measurement of temperature (f), may be assumed to be the overall accuracy of the apparatus since the errors introduced by (b), (c), (d) and (e) will normally be very small compared with (a) and may, therefore, be ignored.

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BASIC ENVIRONMENTAL TESTING PROCEDURES FOR ELECTRONIC AND ELECTRICAL ITEMS

PART XV SEALING TEST

Section 3 Container Sealing, Gas Leakage

1. SCOPE

1.1 This standard (Part XV/Sec 3) deals with the method for detection of gross leaks from container seals of electronic and electrical items.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions and explanation of terms as given in IS : 9000 (Part I)-1977* and Sec 1 of this standard shall apply.

3. OBJECT

3.1 The object of this test is to determine the effectiveness of seals of items having an included gas-filled space (for example, items not completely filled with impregnant).

4. GENERAL DESCRIPTION OF TEST

4.1 The detection of gross leaks is achieved by submerging the test item in a suitable liquid, under controlled conditions and by observing bubbles emanating from the item surface [*see* **2.6** of IS : 9001 (Part VIII)-1982†].

4.2 A positive internal pressure within the test item is generated, by one of the following methods:

a) Method 1 — Conducting the test in a vacuum environment, thereby increasing the pressure differential across the seals of the test item;

b) Method 2 — Through immersion in a test liquid maintained at an elevated temperature [*see* **2.10.1** of IS : 9001 (Part VIII)-1982†]; and

*Basic environmental testing procedures for electronic and electrical items: Part I General.

†Guidance for environmental testing: Part VIII Sealing test.

c) Method 3 — Through immersion in a test liquid, following impregnation with another liquid having a boiling point below the test temperature.

5. TEST APPARATUS

5.1 The chamber shall contain a bath with sufficient liquid to enable the components to be completely immersed to a depth of not less than 10 mm above the uppermost part of the enclosure or seal of the items to be tested.

5.2 For Method 1, the chamber shall be capable of being evacuated to the required low pressure.

5.3 For Method 2, the liquid used in the bath shall be maintained at a temperature of 1 to 5°C above the temperature (dry heat) severity of the items.

6. INITIAL MEASUREMENTS

6.1 The item shall be visually inspected and electrically and mechanically checked as required by the relevant specification.

7. METHOD 1

7.1 The test liquid [*see* **2.9.1** of IS : 9001 (Part VIII)-1982*] shall be maintained at a temperature between 15°C and 35°C.

7.2 Items shall be immersed in the test liquid with their seals uppermost. The pressure within the test chamber shall then be reduced within 1 min to a value of 1 kPa or as otherwise specified in the relevant specification and shall be maintained at this pressure for a further one min, unless repetitive bubbling has been observed at any intermediate pressure [*see* **2.9.1** of IS : 9001(Part VIII)-1982*].

7.3 Items possessing seals on more than one surface shall be tested in accordance with **7.2** with each surface in the uppermost position [*see* **2.5** of IS : 9001 (Part VIII)-1982*].

7.4 There shall be no leakage as determined by repetitive bubbles emerging from the component.

7.5 The immersion chamber or vessel shall be capable of draining the liquid or removing the unit being tested from immersion in the liquid before breaking the vacuum.

8. METHOD 2

8.1 The items which shall be at a temperature between 15°C and 35°C shall be immersed in the test liquid (*see* **5.3**) with their seals uppermost

*Guidance for environmental testing: Part VIII Sealing test.

[*see* **2.10.2** of IS : 9001 (Part VIII)-1982*] for a period of at least 1 min or as prescribed in the relevant specification [*see* **2.4** of IS: 9001 (Part VIII)-1982*].

8.2 Items possessing seals on more than one surface shall be tested in accordance with **8.3** with each surface in the uppermost position [*see* **2.5** of IS : 9001 (Part VIII)-1982*].

8.3 Device failure criteria for this test shall be the observance from a device, during test, a definite stream of bubbles, or more than two large bubbles, or an attached bubble that grows in size [*see* **2.7** and **2.8** of IS : 9001 (Part VIII)-1982*].

9. METHOD 3

9.1 This method consists of two steps:

9.1.1 *Step 1*

a) Step 1 shall be performed at ambient temperature.

b) The item shall be enclosed in a vacuum pressure vessel and the pressure shall be reduced to about 100 Pa for 1 h. Then, without breaking vacuum, an impregnation liquid [*see* **2.11.1** and **2.11.2** of IS: 9001(Part VIII)-1982*] shall be drawn into the vessel until the items are covered by it. After that the items shall be pressurized under the following conditions:

Interval Cavity Volume	*Minimum Pressure (Absolute)*	*Minimum Duration*
$\leqslant 0{\cdot}1 \times 10^{-6}$ m^3	600 kPa	1 h
$> 0{\cdot}1 \times 10^{-6}$ m^3	300 kPa	2 h

c) At the end of this impregnation time, the pressure shall be removed while the items are kept immersed in the impregnation liquid. They shall be removed from the liquid and allowed to dry in air at ambient temperature for 3 ± 1 min or another duration as prescribed in the relevant specification before performing Step 2 [*see* **2.11.3** and **2.11.4** of IS : 9001(Part VIII)-1982*].

9.1.2 *Step 2* — Test Method 2 shall apply for this step, using a test temperature of 125 ± 5°C, unless otherwise specified. The item shall be observed from the instant of immersion until 30 s after immersion, unless otherwise specified in the relevant specification.

*Guidance for environmental testing: Part VIII Sealing test.

10. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

10.1 When this test is included in the relevant specification, the following details shall be given as far as they are applicable:

	Clause Ref
a) Preconditioning, if any	—
b) The method of test	**4**, **7**, **8** and **9**
c) Recommended liquid(s)	**7.1**, **8.1** and **9.1.1**
d) Test Method 1: Pressure if different from **7.2**	**7.2**
e) Test Method 2: Liquid temperature, if different from **5.3**, and	**5.3**
Immersion duration, if different from **8.1**	**8.1**
f) Test Method 3: Step 1 drying time if different from 3 min, and	**9.1.1**(c)
Step 2 temperature, if different from 125°C	**9.1.2**
g) Any deviation from the test procedure	—

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BASIC ENVIRONMENTAL TESTING PROCEDURES FOR ELECTRONIC AND ELECTRICAL ITEMS

PART XV SEALING TEST

Section 4 Container Sealing, Seepage of Filling Liquid

1. SCOPE

1.1 This standard (Part XV/Sec 4) deals with the method for the detection of seepage of filling liquid from container seals of electronic and electrical items.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions and explanation of terms as given in IS : 9000 (Part I)-1977* and Sec 1 of this standard shall apply.

3. OBJECT

3.1 The object of this test is to determine the effectiveness of seals of items filled with liquid.

NOTE — This test may also be used for items having a filling which is solid at room temperature but which is liquid at the testing temperature.

4. TEST CHAMBER

4.1 A dry heat chamber capable of maintaining its working space at the temperature specified (*see* **8.1**) shall be used. In all other respects, dry heat chamber shall conform to IS : 9002 (Part II)-1977†.

5. GENERAL DESCRIPTION OF TEST

5.1 The item shall be examined for seepage of liquid likely to occur when it is brought up to a temperature slightly higher than its maximum ambient temperature of operation.

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*Basic environmental testing procedures for electronic and electrical items: Part I General.

†Specification for equipment for environmental tests for electronic and electrical items: Part II Chamber for dry heat test.

6. SEVERITIES

6.1 The relevant specification shall state one of the following periods for which the item shall be maintained at the test temperature:

a) 10 min
b) 1 h
c) 4 h
d) 24 h
e) 48 h

7. PRECONDITIONING

7.1 The item shall be so cleaned (degreased) using an appropriate method (if necessary at the operating temperature) that possible seepage of liquid is clearly contrasted with all other materials.

8. CONDITIONING

8.1 The item shall be placed with their downwards in an air circulating oven, in which the air is heated until the temperature of the surface of the item(s) is 1 to 5°C above its maximum ambient temperature of operation. The item(s) should occupy an attitude most favourable to reveal leakage.

8.2 The item shall be maintained at the temperature for a period of time according to the severity prescribed in the relevant specification and shall then be removed from the oven.

8.3 Items having seals on more than one face shall be tested in accordance with **8.1** and **8.2** with each such face in the downward position in turn.

8.4 When called for in the relevant specification, the items may be allowed to stand for 10 min under standard atmospheric conditions before final measurements are carried out.

9. FINAL MEASUREMENTS

9.1 The items shall be visually examined for seepage of liquid. There shall be no seepage, unless otherwise specified in the relevant specification.

9.2 The relevant specification shall specify the method of detection [*see* **3.3** of IS : 9001 (Part VIII)-1982*].

*Guidance for environmental testing: Part VIII Sealing test.

10. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

10.1 When this test is included in the relevant specification, the following details shall be given as far as they are applicable:

	Clause Ref
a) Test temperature	**8.1**
b) Duration of conditioning	**8.2**
c) Method of detecting seepage	**9.2**
d) Acceptable performance limits	**9.1**
e) Any deviation from the test procedure	—

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BASIC ENVIRONMENTAL TESTING PROCEDURES FOR ELECTRONIC AND ELECTRICAL ITEMS

PART XV SEALING TEST

Section 5 Sealing-Tracer Gas (Helium) Method with Mass Spectrometer

1. SCOPE

1.1 This standard (Part XV/Sec 5) deals with the method of detection of fine leaks using tracer gas (helium) and a mass spectrometer.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions and explanation of terms as given in IS : 9000 (Part I)-1977* and Sec 1 of this standard shall apply.

3. OBJECT

3.1 The object of this test is to verify the hermeticity of sealed items by evaluating the leak rates with tracer gas (helium) and a mass spectrometer.

4. GENERAL DESCRIPTION OF TEST

4.1 Method 1 — This test method consists of impregnating the item, which has been previously carefully cleaned and dried by placing it in chamber containing a pressurized helium mixture (normally 95 percent He). Helium will diffuse through the traversing cavities and miniature ducts, if any, and penetrate into the inner volumes of the items. After a given time, the item is placed in a chamber which is then evacuated and connected to a mass spectrometer. Helium that exudates out of the item through the leaks is pumped into the mass spectrometer and the leak rate

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is measured. The measured helium leak rate can then be transformed by calculation into the equivalent air leak rate that would exist under standard conditions of temperature and pressure difference, in order to make possible the comparison of items of similar volumes tested under different conditions.

4.2 Method 2 — This test method is similar to Method 1 with the exception of the impregnation phase, which is omitted. This test should be completed within a time which depends on the volume of the item; normally 30 min after package sealing, unless otherwise specified.

5. TEST APPARATUS

5.1 Suitable pressure and vacuum chambers and a mass spectrometer type leak detector preset and properly calibrated for a He leak rate sensitivity, sufficient to read measured helium leak rates of 10^{-10} Pa m^3/s and greater. The volume of the chamber used for leak rate measurement should be held to the minimum practical, since this chamber volume has an adverse effect on sensitivity limits. The leak detector indicator shall be calibrated using a diffusion type certified standard leak at least once during every working shift. For Method 2, all of the above apparatus except the pressure chamber is required.

6. METHOD 1

6.1 Severities — A severity is defined as the combination of immersion pressure (P), immersion time (t_1), and dwell time (t_2).

6.2 Method 1 includes two procedures. Procedure 1 (*see* **6.5**) is a 'fixed' method with specified test parameters that will ensure the test sensitivity necessary to detect the required measured leak rate (R) of helium. Procedure 2 (*see* **6.6**) is a 'flexible' method that allows the variation of test parameters in accordance with the formula given in Appendix A to detect the specified equivalent standard leak rate (L) of air at a predetermined leak rate (R). The severities for Procedure 2 shall be specified in the relevant specification.

6.3 Preconditioning — The item shall be so cleaned that contaminants such as grease, finger prints, flux and lacquer, which are likely to conceal leaks or to adsorb helium are removed. After cleaning, the item shall be stored dry in order to eliminate traces of solvents, capillary, condensations, etc, that may conceal existing leaks.

NOTE — A preliminary study is required for each individual technology used in order to optimise the preconditioning process [*see* **4.6** of IS : 9001 (Part VIII)-1982*].

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6.4 Conditioning

6.4.1 The item shall be placed in a sealed chamber.

6.4.2 The chamber shall be pressurized with the tracer gas of $100 \pm {}^{0}_{5}$ percent helium for the specified time (t_1) and pressure (P).

6.4.3 The pressure shall then be relieved and the item shall be removed from the pressure chamber and shall be subjected to the standard atmospheric conditions for testing. This step may be necessary in order to eliminate helium adsorbed by external surfaces and thereby avoiding unacceptable parasitic signals during the leak rate measurement.

NOTE — The item exposure time to the standard atmospheric conditions is limited by the requirements of **6.4.5**. Dry gas blowing is permissible for accelerating the desorption effects.

6.4.4 The item shall be transferred to a chamber which is connected to the evacuating system and mass spectrometer type leak detector. The chamber shall be evacuated; any tracer gas which was previously forced into the item will thus be drawn out and indicated by the leak detector as measured leak rate (R).

6.4.5 The determination of measured leakage should preferably be completed within the time (t_2) specified under the applicable procedure.

6.5 Procedure 1 — The item shall be tested using the appropriate test parameters as specified in Table 1, depending upon the internal cavity volume of the item under test. This procedure shall not be used if the maximum equivalent standard leak rate limit given in the procurement document is less than the limits specified for the Procedure 2 (*see* **6.6**).

TABLE 1 TEST PARAMETERS FOR PROCEDURE 1

INTERNAL VOLUME OF ITEM (V)	IMMERSION PRESSURE (P)	IMMERSION TIME (t_1)	MAXIMUM DWELL TIME (t_2)	MEASURED LEAK RATE HELIUM (R)
m^3	kPa	h	h	$Pa.m^3/s$
$V < 0{\cdot}4 \times 10^{-6}$	400 ± 10	$2 \pm {}^{0{\cdot}2}_{0}$	1	5×10^{-9}
$V \geqslant 0{\cdot}4 \times 10^{-6}$	400 ± 10	$2 \pm {}^{0{\cdot}2}_{0}$	1	2×10^{-8}
$V \geqslant 0{\cdot}4 \times 10^{-6}$	200 ± 10	$4 \pm {}^{0{\cdot}4}_{0}$	1	1×10^{-8}

6.6 Procedure 2 — The test parameter value shall be chosen such that actual measured leak rate (R) of helium readings obtained for the items under test (if defective) will be greater than the minimum detection sensitivity capability of the mass spectrometer. The items shall be subjected to a minimum of 200 kPa pressure of helium atmosphere. If the chosen dwell time (t_2) is greater than 60 minutes, graphs shall be plotted

to determine an R value which will assure overlap with selected gross leak test condition.

6.6.1 *Failure Criteria* — Unless otherwise specified, the following values of equivalent standard leak rate (L) of air shall be taken as the maximum permissible:

V (m^3)	L ($Pa.m^3/s$)
$\leqslant 0{\cdot}01 \times 10^{-6}$	5×10^{-9}
$0{\cdot}4 \times 10^{-6} \geqslant V > 0{\cdot}01 \times 10^{-6}$	1×10^{-8}
$> 0{\cdot}4 \times 10^{-6}$	1×10^{-7}

6.7 Gross Leaks — Procedure 1 or Procedure 2 shall be followed by a gross leak test using any suitable method, such as, those described in Sec 3 of this standard, or as specified in the relevant specification [*see* **4.5** of IS : 9001 (Part VIII)-1982*].

7. METHOD 2

7.1 This test method may be used for items that have been sealed in such a fashion as to ensure that the package ambient contains a minimum of 20 kPa absolute partial pressure of helium at a standard temperature. Periodical checks shall be made to guarantee that the gas mixture used actually contains the required concentration of helium.

7.2 Upon completion of package seal, the item shall be transferred to a chamber connected to an evacuating system and a mass spectrometer type leak detector. Transfer time (total time between completion of seals and completion of test) shall be less than 30 minutes.

7.3 Any tracer gas that leaks out will be indicated by the leak detector as a measured leak rate (R).

7.4 The measured leak rate (R) shall be converted to the equivalent standard leak rate (L) by applying the following formula:

$$L = R \times \frac{\text{Total internal pressure}}{\text{Helium internal partial pressure}}$$

7.5 Failure Criteria — Unless otherwise specified, the following values of equivalent standard leak rate (L) of air shall be taken as the maximum permissible:

V (m^3)	L ($Pa.m^3/s$)
$\leqslant 0{\cdot}1 \times 10^{-6}$	5×10^{-8}
$> 0{\cdot}1 \times 10^{-6}$	5×10^{-7}

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7.6 Gross Leaks — This method shall be followed by a gross leak test using any suitable method, such as, those described in Sec 3 of this standard, or as specified in the relevant specification [*see* **4.5** of IS : 9001 (Part VIII)-1982*].

8. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

8.1 When this test is included in the relevant specification, the following details shall be given as far as they are applicable:

	Clause Ref
a) Applicable test method	**6** and **7**
Test Method 1	
b) Applicable procedure	**6.2**
c) Test parameters	**6.5** and **6.6**
d) Gross leaks : detection method to be used	**6.7**
e) Failure criteria, if different from that specified in **6.6.1**	**6.6.1**
Test Method 2	
f) Total internal pressure and helium internal partial pressure	**7.4**
g) Gross leaks : detection method to be used	**7.6**
h) Failure criteria, if different from that specified in **7.5**	**7.5**
j) Any deviation from the normal test procedure (for Method 1 and Method 2)	—

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APPENDIX A

(Clause 6.2)

SEALING-TRACER GAS METHOD WITH MASS SPECTROMETER

A-1. At a given temperature, the measured leak rate (R) of helium, in terms of test parameters and equivalent standard leak rate (L) of air is given by the following formula:

$$R = L \times \frac{P}{P_0} \times \left(\frac{Ma}{M}\right)^{\frac{1}{2}} \times \left\{1 - e^{-\frac{L t_1}{V P_0}\left(\frac{Ma}{M}\right)^{\frac{1}{2}}}\right\} \times e^{-\frac{L t_2}{V P_0}\left(\frac{Ma}{M}\right)^{\frac{1}{2}}}$$

where

R = measured leak rate of helium, in $Pa.m^3/s$;

L = equivalent (calculated) standard leak rate of air in $Pa.m^3/s$;

P = absolute pressure of immersion, in Pa;

P_0 = atmospheric pressure, in Pa;

V = internal volume of the item, in m^3;

Ma = specific mass of air in kg/m^3 ($28{\cdot}7\ kg/m^3$);

M = specific mass of helium, in kg/m^3 ($4\ kg/m^3$);

t_1 = immersion time, in seconds; and

t_2 = dwell time between release of pressure and end of leak detection, in seconds.

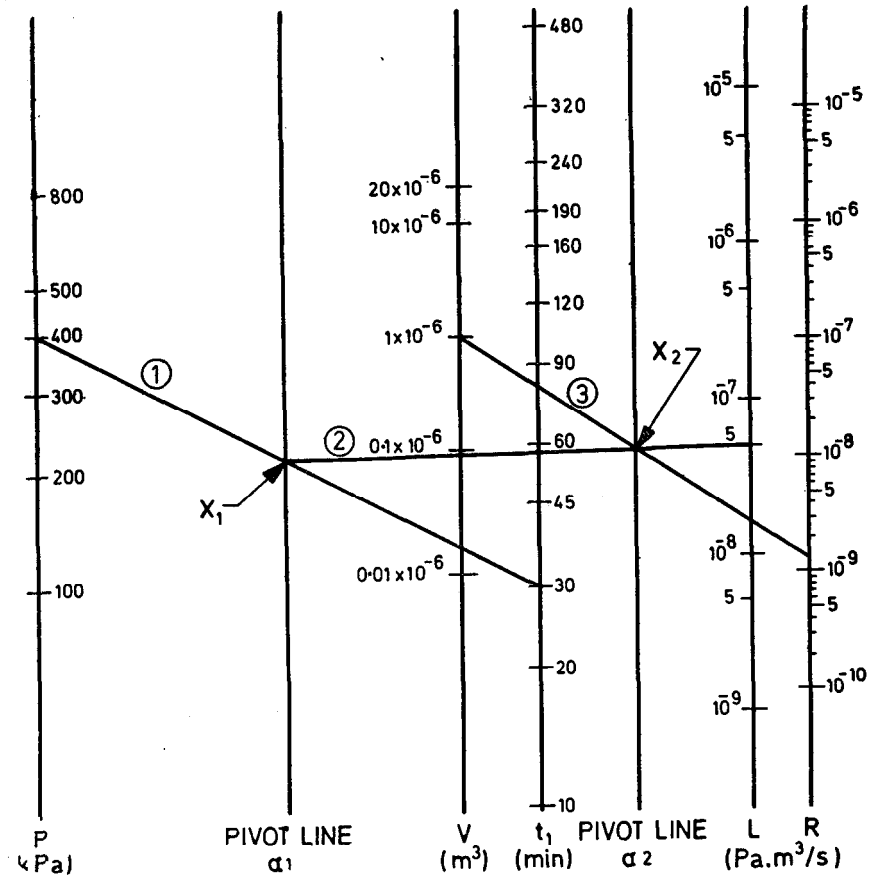
NOTE 1 — This equation can be simplified if one takes into account that the atmospheric pressure is nearly equal to 100 kPa.

NOTE 2 — The influence of temperature may be considered negligible in the temperature range (15 to 35°C) specified under the standard atmospheric conditions for testing.

NOTE 3 — For small values of $\frac{L}{VP_0}$ and t_2, the above formula could be reduced to

$$R = \frac{7{\cdot}175 L^2 P t_1}{V P_0^2} \text{ or } L = P_0 \sqrt{\frac{RV}{7{\cdot}175\ P t_1}}$$

A-2. The chart given in Fig. 1 allows for the determination of R, L or t_1 for given values of the other parameters. It is derived from the reduced formula given above.



NOTE — Important Remark Related to Design of Nomogram: The mathematical construction of this nomogram associates:

P	t_1	and	Pivot line α_1
R	V	and	Pivot line α_2
Pivot line α_1	Pivot line α_2	and	L

It results from this that straight lines may only be drawn *between associated parameters*.

FIG. 1 NOMOGRAM FOR DETERMINATION OF TEST PARAMETERS

A-2.1 Examples of Application

a) Determination of R for given values of L, P, t_1 and V — Draw a straight line across the given values of P and t_1. Its intersection with the pivot line α_1 determines a point. Similarly, a straight line across that very point and the given L determines another point on the pivot line α_2. The straight line drawn across V and point on pivot line α_2 determines the required value on the R scale.

b) Determination of L for given values of R_1, P, t_1 and V — Draw a straight line across the given values of P and t_1. Note its intersection with the pivot line α_1. Similarly, a straight line across R and V determines another point on the pivot line α_2. The straight line drawn across these two points crosses the line L at the required value.

c) Determination of t_1 for given values of L, R, P and V — Draw a straight line across the given values of R and V. Its intersection with the pivot line α_2 determines a point. Similarly, a straight line, drawn across that very point and the given value of L determines another point on the pivot line α_1. The straight line drawn across P and the point on pivot line α_1, determines the required value on t_1 scale.

A-2.2 Application

A-2.2.1 *Problem* — Find out value of R with the help of nomogram given in Fig. 1 corresponding to the following test parameters:

$P = 400$ kPa $\qquad t_1 = 30$ min

$V = 1 \times 10^{-6}$ m^3 $\qquad L = 5 \times 10^{-8}$ Pa.m^3/s

A-2.2.2 *Solution*

Step 1 — Draw a straight line (1) across $P = 400$ and $t_1 = 30$.

Say X_1 is the intersection of this line with the pivot line α_1.

Step 2 — Draw a straight line (2) joining X_1 and $L = 5 \times 10^{-8}$.

Say X_2 is the intersection of this line with the pivot line α_2.

Step 3 — Draw a straight line (3) joining $V = 1 \times 10^{-6}$ and X_2.

The point at which this line cuts the line R will indicate the value of R. Therefore, $R = 1{\cdot}26 \times 10^{-9}$ Pa.m^3/s.

A-2.3 For example, a few combinations of test parameters for Procedure 2 of Method 1 are given in Table 2. The values have been calculated using the nomogram given in Fig. 1.

TABLE 2 EXAMPLES OF TEST PARAMETERS FOR PROCEDURE 2

(*Clause* A-2.3)

P	t_1	V	L	R
kPa	min	m^3	$Pa.m^3/s$	$Pa.m^3/s$
200	30	$0{\cdot}01 \times 10^{-6}$	5×10^{-9}	7×10^{-10}
300	30	$0{\cdot}01 \times 10^{-6}$	5×10^{-9}	1×10^{-9}
400	30	$0{\cdot}01 \times 10^{-6}$	5×10^{-9}	$1{\cdot}3 \times 10^{-9}$
500	30	$0{\cdot}01 \times 10^{-6}$	5×10^{-9}	2×10^{-9}
200	60	$0{\cdot}1 \times 10^{-6}$	1×10^{-8}	5×10^{-10}
300	45	$0{\cdot}1 \times 10^{-6}$	1×10^{-8}	5×10^{-10}
400	30	$0{\cdot}1 \times 10^{-6}$	1×10^{-8}	5×10^{-10}
500	30	$0{\cdot}1 \times 10^{-6}$	1×10^{-8}	6×10^{-10}
200	120	$0{\cdot}4 \times 10^{-6}$	1×10^{-8}	$2{\cdot}3 \times 10^{-10}$
300	90	$0{\cdot}4 \times 10^{-6}$	1×10^{-8}	$2{\cdot}3 \times 10^{-10}$
400	60	$0{\cdot}4 \times 10^{-6}$	1×10^{-8}	$2{\cdot}3 \times 10^{-10}$
500	45	$0{\cdot}4 \times 10^{-6}$	1×10^{-8}	$2\,3 \times 10^{-10}$
200	240	$10\,0 \times 10^{-6}$	1×10^{-7}	2×10^{-9}
300	160	$10{\cdot}0 \times 10^{-6}$	1×10^{-7}	2×10^{-9}
400	120	$10\,0 \times 10^{-6}$	1×10^{-7}	2×10^{-9}
500	60	$10{\cdot}0 \times 10^{-6}$	1×10^{-7}	$1{\cdot}3 \times 10^{-9}$
200	480	$20{\cdot}0 \times 10^{-6}$	1×10^{-7}	2×10^{-9}
300	320	$20{\cdot}0 \times 10^{-6}$	1×19^{-7}	2×10^{-9}
400	240	$20{\cdot}0 \times 10^{-6}$	1×10^{-7}	2×10^{-9}
500	190	$20{\cdot}0 \times 10^{-6}$	1×10^{-7}	2×10^{-9}

A-2.4 The performance criteria may also be expressed in terms of time constant 0, where $\theta = \frac{P_0 V}{L}$. For further details, *see* **4.7** and **4.8** of IS : 9001 (Part VIII)-1982*.

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BASIC ENVIRONMENTAL TESTING PROCEDURES FOR ELECTRONIC AND ELECTRICAL ITEMS

PART XV SEALING TEST

Section 6 Bomb Pressure Test

1. SCOPE

1.1 This standard (Part XV/Sec 6) deals with the procedure for detecting the effectiveness of seals of electronic and electrical items whose electrical characteristics will be affected by penetration of liquid.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions and explanation of terms as given in IS : 9000 (Part I)-1977* and Sec 1 of this standard shall apply.

3. OBJECT

3.1 The object of this test is to determine the effectiveness of seals of items whose electrical characteristics will be affected by penetration of liquid.

4. GENERAL DESCRIPTION OF TEST

4.1 This method consists in allowing a test liquid to penetrate through a leak to the interior of the item under test. This method is commonly known as the bomb pressure test.

4.2 The test liquid shall possess the property of producing detectable changes in the electrical characteristics of the item. Assessment of the leakage is achieved by measuring those specified electrical parameters which are influenced by the penetration of the test liquid (for example, a suitable alcohol).

4.3 Adding of pigment to the test liquid can show the path of penetration after opening the item under test. As it usually requires some time for the penetration of the test liquid to affect the electrical characteristics,

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repeated measuring, separated by short periods of storage, may be necessary.

4.4 The maximum sensitivity of the method is limited at approximately 10^{-6}Pa.m^3/s. No quantitative information on the leakage rate can be obtained.

5. INITIAL MEASUREMENTS

5.1 The items shall be visually inspected and electrically and mechanically checked as required by the relevant specification.

6. CONDITIONING

6.1 The pressure vessel (bomb) shall contain the type of test liquid as required by the relevant specification. Preference shall be given to alcohol and/or water with a detergent [*see* **5.5** of IS : 9001 (Part VIII)-1982*].

6.2 The test liquid shall be at standard atmospheric conditions for testing or at the temperature specified by the relevant specification.

6.3 The items shall be placed in the pressure vessel in such a manner that they are fully submerged in the test liquid.

6.4 The pressure within the test vessel shall be raised to the value specified in the relevant specification.

NOTE — The maximum pressure depends mainly on the construction of the item. It should normally not exceed 500 kPa [*see* **5.4** of IS : 9001 (Part VIII)-1982*].

6.5 The duration of the conditioning shall be as specified by the relevant specification, but shall normally be not more than 16 h. In special cases, that is, when using lower pressures, the duration may be raised to 24 h.

6.6 The pressure in the vessel shall then be reduced to atmospheric pressure and the items shall be removed from the vessel.

7. RECOVERY

7.1 If required by the relevant specification, the items shall be cleaned by means of a suitable liquid. In this case, the type of cleaning liquid shall be specified in the relevant specification.

7.2 The items shall be dried by applying a blast of air at laboratory temperature for a short period.

7.3 The items shall then be subjected to atmospheric conditions for recovery for a period as required by the relevant specification.

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8. FINAL MEASUREMENTS

8.1 The items shall be visually inspected and electrically checked as required by the relevant specification.

NOTE — In case of doubtful results the measurements shall be repeated after a suitable recovery period.

9. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

9.1 When this test is included in the relevant specification, the following details shall be given, as far as they are applicable:

	Clause Ref
a) Measurements prior to conditioning	**5**
b) Type of test liquid	**6.1**
c) Temperature of the test liquid	**6.2**
d) Pressure in the test vessel	**6.4**
e) Duration of conditioning	**6.5**
f) Cleaning and type of liquid	**7.1**
g) Duration of recovery	**7.3**
h) Measurements after recovery	**8**
j) Repeated recovery and repeated measurements	**8.1**
k) Any deviation from the test procedure	—

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BASIC ENVIRONMENTAL TESTING PROCEDURES FOR ELECTRONIC AND ELECTRICAL ITEMS

PART XV SEALING TEST

Section 7 Immersion Test

1. SCOPE

1.1 This standard (Part XV/Sec 7) deals with the method for determination of water tightness of electronic and electrical items.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions and explanation of terms as given in IS : 9000 (Part I)-1977* and Sec 1 of this standard shall apply.

3. OBJECT

3.1 The object of this test is to determine the water tightness of items when subjected to immersion under stated conditions of pressure and time.

4. GENERAL DESCRIPTION OF TEST

4.1 The item is submitted to a specified pressure by immersion in a water tank at a specified depth or in a high pressure water chamber. After conditioning, the item is examined for penetrated water and checked for possible changes of characteristics.

5. TEST APPARATUS

5.1 A suitable water tank or a high pressure water chamber capable of providing the conditions stated in Table 1 shall be used.

6. INITIAL MEASUREMENTS

6.1 The items shall be visually inspected and shall be electrically and mechanically checked as required by the relevant specification. All

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sealing features shall be checked to ascertain that they have been correctly mounted.

7. PRECONDITIONING

7.1 Preconditioning of the items and seals should be carried out, where prescribed by the relevant specification.

8. CONDITIONING

8.1 The items shall be placed in the position as specified in the relevant specification and shall be completely immersed in a water tank or high pressure water chamber.

8.2 The items shall be subjected to one of the head-of-water values or the corresponding pressure difference given in Table 1 as required by the relevant specification.

8.2.1 When a tank is used, the specified head of water shall be measured above the highest point of the item.

8.2.2 When a high pressure water chamber is used, the water pressure shall be adjusted to the pressure difference of Table 1.

8.3 The duration shall be as specified in the relevant specification. Preferred values shall be 30 min, 2 h, 24 h.

8.4 The temperature of the item under test shall be not less than the temperature of the water, and not more than 10°C above the temperature of the water, the latter not exceeding 35°C.

8.5 Unless otherwise specified in the relevant specification, during immersion, the item under test shall not be in operation; it shall be switched off and its movable parts shall be at rest.

TABLE 1 HEAD-OF-WATER (OR PRESSURE DIFFERENCE) VALUES

(*Clauses* 5.1, 8.2 *and* 8.2.2)

Head of Water	Corresponding Pressure Difference (at 25°C)
m	kPa
0·15	1·47
0·40	3·91
1	9·78
1·50	14·7
4	39·1
6	58·7
10	97·8
15	147·0
265	2 591·7

Note — Sea water may be used in case of severities 10, 15, and 265 m.

9. RECOVERY

9.1 The item shall be thoroughly dried externally by wiping or by applying a blast of air at room temperature, unless otherwise specified by the relevant specification.

10. FINAL MEASUREMENTS

10.1 The item shall be examined for water penetration and shall be visually inspected and electrically and mechanically checked as required by the relevant specification.

11. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

11.1 When this test is included in the relevant specification, the following details shall be given as far as they are applicable:

	Clause Ref
a) Electrical and mechanical checks prior to conditioning	**6**
b) Preconditioning procedure	**7**
c) Position during conditioning	**8.1**
d) Head of water or pressure difference	**8.2**
e) Duration of conditioning	**8.3**
f) Electrical and mechanical checks after recovery	**10**
g) Any deviation from the test procedure	—

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BASIC ENVIRONMENTAL TESTING PROCEDURES FOR ELECTRONIC AND ELECTRICAL ITEMS

PART XV SEALING TEST

Section 8 Sealing-Radioactive Tracer Gas (Krypton) Method

1. SCOPE

1.1 This standard (Part XV/Sec 8) deals with the method of detection of fine leaks using krypton gas.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions and explanation of terms as given in IS : 9000 (Part I)-1977* and Sec 1 of this standard shall apply.

3. OBJECT

3.1 The object of this test is to determine the leak rate of electronic and electrical items by measuring the radiation level present within the item after having been pressurized in a chamber with suitable radioactive tracer gas such as krypton.

4. APPLICABILITY

4.1 This test method is applicable for items which are designed to be hermetically sealed in glass, metal or ceramic (or combination thereof) encapsulations and is suitable for leak rate smaller than 10^{-6} Pa.m^3/s.

NOTE — The numerical values given are applicable for krypton-85 tracer gas and for leak rate limit near 5×10^{-9} Pa.m^3/s. The use of other tracer gases would require other numerical values.

5. TEST APPARATUS

5.1 The apparatus for this test shall consist of the following.

5.1.1 *Radioactive Tracer Gas Activation Console* — The activation chamber may be partially filled with inert material to reduce evacuation time.

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5.1.2 *Counting Equipment (Consisting of a Scintillation Crystal, Photomultiplier Tube, Pre-amplifier, Rate-Meter and Krypton-85 Reference Standards)* — The counting station shall be of sufficient sensitivity to determine through the device wall the radiation level of any krypton-85 tracer gas present within the device. The counting station shall have a minimum sensitivity, in counts per minute, corresponding to a leak rate of 1×10^{-10} Pa. m^3/s of krypton-85 and shall be calibrated at least once every working shift using krypton-85 reference standards and following the equipment manufacturers instruction.

5.1.3 *Tracer Gas (Consisting of Mixture of Krypton-85 and Dry Nitrogen)* — The concentration of krypton-85 in dry nitrogen shall be no less than 100 curies per atmospheric m^3. This value shall be determined at least once in 30 days, recorded and certified.

6. CONDITIONING

6.1 The items shall be placed in a radioactive tracer gas activation tank. The tank shall be evacuated to at least 50 Pa. The actual pressure and soak time shall be determined in accordance with **A-1.**

6.2 The items shall be subjected to a minimum of 200 kPa absolute pressure of krypton-85/dry nitrogen mixture for a minimum of 12 min. The krypton-85/dry nitrogen gas mixture shall be evacuated until a pressure less than 50 Pa exists in the activation tank. This evacuation shall be complete in 5 min, maximum.

6.3 The activation tank shall then be backfilled with air (air wash). The items shall then be removed from the activation tank, and leak tested within 2 h after gas exposure.

6.4 The item encapsulations that come under requirements of **A-3** shall be exposed to ambient air for a time not less than the ' wait time ' determined in **A-3**. In no case shall the time between removel from the actuation chamber and test exceed 2 h. The item encapsulations that do not come under the requirements of **A-3** may be tested without a ' wait time '.

6.5 If the test is to be repeated on the same item(s), then they shall be first decontaminated in vacuum for 8 h, prior to repressurization.

6.6 The actual leak rate of the item shall be calculated with the following equation:

$$Q = \frac{(\text{Actual readout in net counts per minute}) \times Q_s}{R}$$

where

Q = actual leak rate in $Pa.m^3/s$, and

Q_s and R as defined in **A-1.1.**

6.7 Personnel Precautions — Applicable regulations* for the use of radioactive gas should be followed.

7. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

7.1 When this test is included in the relevant specification, the following detail shall be given as far as applicable:

Limit of the leak rate.

APPENDIX A

(*Clauses* 6.1, 6.4. *and* 6.6)

CALCULATION OF PARAMETERS

A-1. ACTIVATION PARAMETERS

A-1.1 The activation pressure and soak time shall be determined in accordance with the following equation (*see* Note):

$$Q_s = \frac{R}{3\,600\, sk\, \bar{P}\, T} \qquad \ldots (1)$$

where

Q_s = the maximum leak rate allowable for the items to be tested in $Pa.m^3/s$;

R = 1 200 counts per minute above the ambient background after activation if the item leak rate were exactly equal to Q_s. This is the reject count above the background of both the counting equipment and the component if it has been through previous radioactive leak tests;

s = the specific activity, in microcuries per Pam^3 of krypton-85 gas in the activation system;

k = the overall counting efficiency of the scintillation crystal in counts per minute per one microcurie of krypton-85 in the internal cavity of the specific item being evaluated. This factor depends upon configuration of the item and dimensions of the scintillation crystal. The counting efficiency shall be determined in accordance with **A-2**;

*These regulations are stipulated by the Department of Radiation Protection, Bhabha Atomic Research Centre, Bombay (India).

T = soak time that the items are to be activated, in hours; and

$\bar{P}$ = $P_e^2 - P_1^2$, where P_e is the absolute activation pressure in Pascals and P_1 is the original absolute internal pressure of the items in pascals. The activation pressure (P_e) may be established by specification, or if a convenient soak time (T) has been established, the activation pressure (P_e) can be adjusted to satisfy equation (1).

NOTE — The complete version of equation (1) contains a factor $P_0^2 - (\triangle P)^2$ in the numerator which is a correction factor for elevation above sea level. P_0 is the sea level absolute pressure, in Pascals, and $\triangle P$ is the difference in pressures, in Pascals, between the actual pressure at the test station and sea level pressure. For the purposes of this test, this factor is neglected.

A-2. COUNTING EFFICIENCY (k)

A-2.1 The counting efficiency (k) of equation (1) shall be determined as follows:

a) A representative unit of the item type to be tested shall be provided with a tube to its internal cavity and the cavity shall be backfilled through the tube with known volume and specific activity of krypton-85 tracer gas and the tubulation should be sealed off; and

b) The counts per minute in the shielded scintillation crystal of the counting station in which the items are tested shall be directly read.

A-3. EVALUATION OF THE SURFACE SORPTION

A-3.1 For each type of encapsulation to be tested, the coatings and external sealants shall be evaluated for surface sorption of krypton-85 before establishing the leak test parameters. Representative samples of the items shall be subjected to the predetermined pressure and time conditions established for the item configuration as specified in **5** and **A-1**. The count rate of the samples shall then be noted every 10 min, until it becomes constant. The elapsed time shall be noted and is the ' wait time '.

Indian Standard

BASIC ENVIRONMENTAL TESTING PROCEDURES FOR ELECTRONIC AND ELECTRICAL ITEMS

PART XV SEALING TEST

Section 9 Sealing-Test for Equipment

1. SCOPE

1.1 This standard (Part XV/Sec 9) deals with the procedure for sealing test primarily intended for equipment type electronic and electrical items.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions and explanation of terms as given in IS : 9000 (Part I)-1977* and Sec 1 of this standard shall apply.

3. OBJECT

3.1 The object of this test is to determine the effectiveness of sealing of electronic and electrical items.

4. TEST EQUIPMENT

4.1 For Procedures 1 and 2 — The test set up shall consist of the following items.

4.1.1 A dry heat chamber conforming to requirements of IS : 9002 (Par II)-1977†.

4.1.2 A cold chamber conforming to requirements of IS : 9002 (Part I)-1977‡.

4.1.3 A vacuum pump capable of producing vacuum equivalent to an air pressure of 25 kPa.

4.1.4 A sensitive pressure gauge capable of reading air pressure accurately to less than 0·7 kPa.

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*Basic environmental testing procedures for electronic and electrical items: Part I General.

†Equipment for environmental tests for electronic and electrical items: Part II Chamber for dry heat test.

‡Equipment for environmental tests for electronic and electrical items: Part I Chamber for cold test.

4.1.5 A source of compressed dry air or dry nitrogen at the required pressure.

4.1.6 An air flow meter.

4.1.7 Nozzle and inter-connecting hoses.

4.2 For Procedure 3

4.2.1 A high air pressure chamber capable of attaining pressure differentials specified in Table 1, shall be used for this procedure. The chamber shall be capable of maintaining the required pressure for the duration specified in **5.3.5**.

TABLE 1 PRESSURES FOR EXCESS PRESSURE TEST

(*Clauses* 4.2.1 *and* 5.3.4)

Maximum Pressure Differential kPa (*see* Note 1)	Differential Test Pressure kPa $^{+5}_{-0}$ Percent (*see* Note 2)
76	86
36	41

NOTE 1 — In the test conditions stated above, the pressurization level for ground testing has been assumed equal to the maximum level occurring in flight for the particular class of aircraft.

NOTE 2 — The test pressure is based on a proof test concept and is the maximum pressure differential multiplied by 1·125.

4.2.2 The chamber shall also be capable of maintaining its working space at the temperatures of $-20 \pm 3°C$ and $70 \pm 3°C$, and for this purpose shall meet the requirements specified in IS : 9002 (Part I)-1977* and IS : 9002 (Part II)-1977†.

4.3 For Procedures 4 and 5

4.3.1 A low air pressure chamber capable of attaining pressures specified in Table 2 at rates specified in **5.4.5** and **5.5.5**, shall be used for this procedure. The chamber shall be capable of maintaining the required pressure for the duration specified in **5.4.6** and **5.5.6**.

4.3.2 The chamber shall also be capable of maintaining its working space at the temperatures of $-20 \pm 3°C$ and $40 \pm 3°C$ and for this purpose shall meet the requirements specified in IS : 9002 (Part I)-1977* and IS : 9002 (Part II)-1977†.

*Equipment for environmental tests for electronic and electrical items: Part I Chamber for cold test.

†Equipment for environmental tests for electronic and electrical items: Part II Chamber for dry heat test.

TABLE 2 PRESSURES FOR RAPID DECOMPRESSION TESTS

(*Clauses* 4.3.1, 5.4.4 *and* 5.4.5)

Pressurization Level kPa Absolute $^{+5}_{-0}$ Percent	Test Pressure Related to Maximum Flight Altitude kPa Absolute ± 5 Percent
87·5	11·5
80·5	4·5
51·5	11·5
47·0	7·0
44·5	4·5

5. CONDITIONING

5.0 The equipment shall be subjected to this test in its 'unpacked' and 'switched-off' condition. Five procedures are specified. The equipment shall be subjected to one or more of these procedures as required by the relevant specification.

NOTE — For procedure 1 or 2 of this test to be possible, a suitable nozzle should be available on the equipment for providing connection to vacuum pump/gas source and pressure gauge, etc.

5.1 Procedure 1 — Sealing Test (Vacuum)

5.1.1 The equipment nozzle shall be connected to a vacuum pump (*see* **4.1.3**) and pressure gauge.

5.1.2 The equipment temperature shall then be stabilized at 20 ± 2°C.

5.1.3 The equipment shall then be evacuated until a vacuum corresponding to one of the following test conditions, as required by the relevant specification, is achieved:

a) Test condition A : Air pressure equal to 25 kPa, and

b) Test condition B : Air pressure equal to 50 kPa

5.1.4 The equipment shall then be sealed off from the pump and allowed to stand for 30 min, after which the reading in pressure gauge shall be noted.

5.1.5 For equipment sealing to be satisfactory the air pressure reading at the end of 30 min period should not have falled by more than 10 kPa.

5.2 Procedure 2 — Sealing Test (Pressure)

5.2.1 This procedure includes three methods. Methods A and B are applicable to equipment which are 'statically' pressurized, that is, the

equipment is pressurized and sealed initially and the pressure within the equipment is not maintained during operation. Method C is applicable to the equipment within which constant pressure is maintained.

5.2.2 This test shall be conducted at one or more of the following temperatures, as required by the relevant specification:

a) 20 ± 2°C,

b) Highest operating temperature of the equipment, and

c) Lowest operating temperature of the equipment.

5.2.3 *Method A*

5.2.3.1 This method shall be used for determination of leakage time constant, which is the time taken for the pressure within the equipment to fall by a ratio of 2·718.

5.2.3.2 The equipment nozzle shall be connected to a pressure gauge and a source of pressurized dry air or dry nitrogen.

5.2.3.3 The equipment temperature shall then be stabilized at the value specified (*see* **5.2.2**).

5.2.3.4 The pressure within the equipment shall be adjusted accurately to an initial value specified in the relevant specification and time shall be noted.

5.2.3.5 The pressure shall be recorded at measured time intervals, a correction being applied, if necessary, for any variation in temperature at the time of reading the pressure. The test shall be continued for at least half the value of time constant.

5.2.3.6 The leakage time constant shall be determined graphically by extrapolation assuming an exponential fall in pressure.

5.2.4 *Method B*

5.2.4.1 This method shall be used for determination of the leakage rate.

5.2.4.2 The equipment shall be connected to a source of pressurized dry air or dry nitrogen and a sensitive pressure gauge.

5.2.4.3 The equipment temperature shall be stabilised at the value specified (*see* **5.2.2**).

5.2.4.4 The pressure within the equipment shall be adjusted accurately to a value specified in the relevant specification and time shall be noted.

5.2.4.5 The rate of fall of pressure shall be determined. Correction for change in temperature shall be made where necessary. Generally the test shall be continued until the pressure has fallen by at least 1·4 kPa.

5.2.5 *Method C*

5.2.5.1 This method shall be used for determination of leakage rate for the equipment where constant pressure is maintained during operation by measurement of rate of flow of the dry air/nitrogen required to maintain the pressure.

5.2.5.2 The equipment shall be connected to a source of pressurized dry air or dry nitrogen through a suitable flow meter and a pressure gauge (*see* **4.1.4**).

NOTE — The gas source shall be maintained at a pressure slightly in excess of that specified in the relevant specification.

5.2.5.3 The equipment temperature shall be stabilized at the value specified (*see* **5.2.2**)

5.2.5.4 The rate of flow of air into the equipment shall be determined, a correction being applied as necessary for variation of temperature.

5.3 Procedure 3 — Excess Pressure Test

5.3.1 Equipment normally pressurized or evacuated shall have the internal pressure adjusted to the most adverse design limit that would be experienced at ground level.

5.3.2 The equipment shall be placed in the test chamber and oriented into its normal attitude if this is significant, as required by the relevant specification.

5.3.3 The test chamber shall be conditioned for a period sufficient to allow the equipment to stabilize at one of the following temperatures, as required by the relevant specification.

a) Temperature corresponding to standard testing conditions,

b) -20 ± 3°C, and

c) 70 ± 3°C.

NOTE — The test shall be applied initially at temperature corresponding to (a) above, and additionally at −20°C or 70°C, or both, if temperature is likely to contribute to failure.

5.3.4 The pressure within the chamber shall then be increased by the appropriate differential test pressure given in Table 1 as required by the relevant specification, in a period of not less than 5 min and not greater than 15 min.

5.3.5 The pressure shall be maintained at this level for a period of not less than 30 min, and shall finally be restored to laboratory conditions in a period of not less than 5 min and not greater than 15 min.

5.3.6 The equipment shall be subjected to this test in its idle or inert condition, unless it is a functional part of the aircraft during a pressurization check. In this event the equipment should be operated and made to function in the representative manner as required by the relevant specification.

5.4 Procedure 4 — Rapid Decompression Test

5.4.1 Equipment normally pressurized or evacuated shall have the internal pressure adjusted to the most adverse design limit that would be experienced at ground level.

5.4.2 The equipment shall be placed in the test chamber and oriented into its normal attitude if this is significant, as required by the relevant specification.

5.4.3 The test chamber shall be conditioned for a period sufficient to allow the equipment to stabilize at one of the following temperatures as required by the relevant specification:

a) Temperature corresponding to standard testing conditions,

b) -20 ± 3°C, and

c) -40 ± 3°C.

NOTE — The test shall be applied initially at temperature corresponding to (a) above, and additionally at −20°C or 40°C, or both, if temperature is likely to contribute to failure.

5.4.4 The pressure within the chamber shall then be reduced to the appropriate pressurization level stated in Table 2 as required by the relevant specification and shall be maintained at this level for a period of not less than 5 min.

5.4.5 The pressure shall then be further reduced to that corresponding to the appropriate maximum flight altitude stated in Table 2 in a period not exceeding one minute, or if allowed by the relevant specification at the maximum rate of change obtainable from the test chamber [*see* **6** of IS : 9001 (Part VIII)-1982*].

5.4.6 The pressure shall then be maintained at this level for a period of not less than 10 min, or for any other period specified by the relevant specification.

5.4.7 The relevant specification may require the temperature to be changed to simulate temperature levels resulting from pressurization failure, and/or the pressure to be increased to simulate descent to a more acceptable flight altitude. The relevant specification shall state the conditioning required.

*Guidance for environmental testing: Part VIII Sealing test.

5.4.8 The equipment, unless the test is being made with equipment in its idle or inert state, shall be operated and its performance checked at the phases of the test specified by the relevant specification.

5.5 Procedure 5 — Explosive Decompression Test

5.5.1 Equipment which is normally pressurized or evacuated shall have the internal pressure adjusted to the most adverse design limit that would be experienced at ground level.

5.5.2 The equipment shall be placed in the test chamber and oriented into its normal attitude if this is significant, as required by the relevant specification.

5.5.3 The test chamber shall be conditioned for a period sufficient to allow the equipment to stabilize at one of the following temperatures as required by the relevant specification:

a) Temperature corresponding to standard testing conditions,

b) $-20 \pm 3°C$, and

c) $40 \pm 3°C$.

NOTE — The test shall be applied initially at temperature corresponding to (a) above, and additionally at −20°C or 40°C, or both, if temperature is likely to contribute to failure.

5.5.4 The pressure within the chamber shall then be reduced to the appropriate pressurization level stated in Table 3 as required by the relevant specification and shall be maintained at this level for a period of not less than 5 min.

TABLE 3 PRESSURES FOR EXPLOSIVE DECOMPRESSION TEST

PRESSURIZATION LEVEL kPa ABSOLUTE (*see* Note) $^{+5}_{-0}$ Percent	TEST PRESSURE RELATED TO MAXIMUM FLIGHT ALTITUDE kPa ABSOLUTE ± 5 Percent
51·5	11·5
47·0	7·0
44·5	4·5

NOTE — The test conditions stated above are based upon a pressurization differential of 36 kPa which has been increased to 40 kPa to allow for suction effects.

5.5.5 The pressure shall then be further reduced to that corresponding to the appropriate maximum flight altitude in a period not exceeding 100 ms.

5.5.6 The pressure shall then be maintained at that level for a period not less than 10 min, or for any other period as specified by the relevant specification.

5.5.7 The relevant specification may require the temperature to be changed to simulate temperature levels resulting from pressurization failure and/or the pressure to be increased to simulate descent to a more acceptable flight altitude. The relevant specification shall state the conditioning required.

5.5.8 The equipment, unless the test is being made with equipment in its inert or idle state, shall be operated and its performance checked at the phases of the test specified by the relevant specification.

6. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

6.1 When this test is included in the relevant specification, the following details shall be given as far as they are applicable:

	Clause Ref
a) Applicable procedure	**5.0**
b) *For Procedure 1*: applicable test condition	**5.1.3**
c) *For Procedure 2*:	
Applicable test method	**5.2.1**
Temperature(s) at which test is to be conducted	**5.2.2**
Initial pressure	**5.2.3.4, 5.2.4.4** and **5.2.5.2**
Acceptable leakage time constant or leakage rate	**5.2.3.6, 5.2.4.5** and **5.2.5.4**
d) *For Procedure 3*:	
Mounting of equipment in the chamber	**5.3.2**
Test temperature(s)	**5.3.3**
Test pressure	**5.3.4**
Details of operation and performance check, if required	**5.3.6**
e) *For Procedure 4*:	
Mounting of equipment in the chamber	**5.4.2**
Test temperature(s)	**5.4.3**

	Clause Ref
Pressurization level	**5.4.4**
Test pressures related to maximum flight altitude	**5.4.5**
Whether a rate of change, lower than 1 min is allowed	**5.4.5**
Duration of maximum flight altitude	**5.4.6**
Conditioning following decompression phase, stating temperature and pressure	**5.4.7**
Details of operation and performance check	**5.4.8**
f) *For Procedure 5*:	
Mounting of equipment in the chamber	**5.5.2**
Test temperature(s)	**5.5.3**
Pressurization level	**5.5.4**
Pressure related to maximum flight altitude	**5.5.5**
Duration of pressure related to maximum flight altitude	**5.5.6**
Conditioning following decompression phase, stating temperature, and pressure	**5.5.7**
Details of operation and performance check	**5.5.8**
g) Any deviation from the test procedure	—